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POST-GLACIAL LAKES IN THE MACKENZIE RIVER BASIN, NORTH WEST TERRITORIES, CANADA

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It is a well-known fact that lakes or ponds of impounded water would form whenever the retreating continental ice sheet receded down a stream valley. It is therefore evident that the run-off from the eastward slopes of the Rocky Mountain cordillera would be impounded behind the retreating ice front of the Keewatin glacier as it receded, and the lakes so formed would expand laterally along the margin of the ice sheet, and the water would collect both from the inflowing streams and the melting ice until it rose above the lowest point in the stream valley walls, when it would spill over and form a new river course, possibly at considerable variance to the pre-established drainage lines. Thus we would expect to find evidence of ice-dammed lakes of greater or less magnitude throughout large areas in the northern portions of the great plains area of the Dominion of Canada. It is not the object of this paper to deal with the possible extent of such lakes throughout the northern regions, but rather to consider one or two specific stages in the lake expansions as they were apparently developed in the lower Peace and Athabaska river valleys, Athabaska Lake and Great Slave Lake.

The area to be discussed is shown in the accompanying map (Fig. 1). It lies between latitudes 56° north and 63° north, longitudes 107° west and 120° west, and it comprises the lower portions of the valleys of Peace and Athabaska rivers, Athabaska Lake and Great Slave Lake.

Tyrrell,[1] in his report on Athabaska Lake and Churchill River, makes frequent reference to the great post-glacial lakes of this region. He says:

> North of the watershed between Churchill and Stone rivers, most of the akes appear to have stood at a higher level than they do at present, in the time immediately subsequent to the retirement of the great ice-sheet. The natural inference is that they lay between the face of the waning ice-sheet and higher land over which the water flowed to form the great rivers of the glacial period.

He proposed the addition of the prefix "hyper-" to the name of the present lake or river to designate the former high-level lake that occupied its basin or valley.

Tyrrell's report covers the area east of Athabaska River and south of Athabaska Lake, and is therefore in part included in the region under discussion. Certain parts of his reports are of prime importance in any consideration of the question. Particular reference must be made to his Hyper-Black Lake, Hyper-Athabaska Lake, and Hyper-Churchill Lake. Black Lake lies directly east of the eastern extremity of Athabaska Lake and is connected with Athabaska Lake by a broad, trenchlike valley at present occupied by Stone River. Tyrrell says:

> Hyper-Black Lake stood 125 feet above the present level of Black Lake, and extended for a long distance up Cree and Stone rivers. Hyper-Athabasca Lake rose above the present level of Lake Athabasca, as is shown by the beautiful raised beaches on Beaver-lodge Island, and the wide sandy plains seen by Mr. Dowling on William River; but whether it at any time was confluent with Hyper-Black Lake was not determined. . . . . Hyper-Churchill Lake lay in the present valley of Churchill River, and, when at its greatest height, seems to have extended southward as far as the sand-hills around Clearwater Lake on the Green Lake trail.

[1] J. B. Tyrrell, "Athabasca Lake and Churchill River," *G.S.C. Annual Report*, New Series, Vol. VII, "D," 1895.

From a perusal of Tyrrell's report it is possible to outline at least one main drainage channel of the great post-glacial lakes that is of particular importance to our problem.

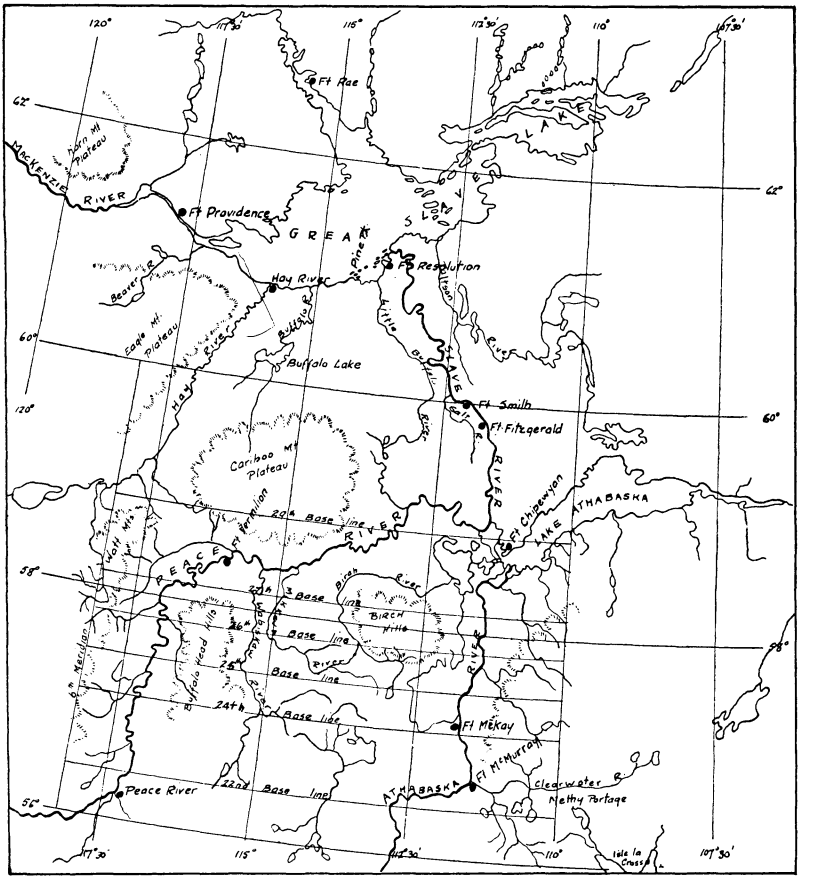

FIG. 1.—Map of portion of Mackenzie River basin, showing lower portions of Peace and Athabaska river valleys and basins of Athabaska Lake and Great Slave Lake. Scale, 1 inch = 117 miles.

This channel appears to connect with the Clearwater River valley at Methy portage, following it southeast through Buffalo Lake, Isle la Crosse Lake, Beaver River, Green Lake, Big River, and Shell Creek to the valley of the Saskatchewan. It is reported as a broad, trenchlike valley with the watershed between the Saskatche-

wan and Churchill rivers lying in a sandy plain at the bottom of the deep valley. As will be shown later, a portion of this valley probably at one time was the principal drainage channel of great post-glacial lakes lying in the Athabaska and Peace river valleys, though possibly Hyper-Churchill Lake intervened to take the waters from Hyper-Athabaska Lake before discharging them into the Saskatchewan River.

A second channel is suggested in his account of the east end of Athabaska Lake and the valley of Stone River below Black Lake. This appears as a short, narrow channel connecting the waters of Hyper-Athabaska Lake with those of Hyper-Black Lake. It would seem very probable that during a certain period of the lake formations these two bodies of water were confluent by way of this channel, and that the outlet of the chain of lakes lay possibly by way of Mudjatick River Valley to Hyper-Churchill Lake or by another channel farther east.

Just at the eastern end of Athabaska Lake Tyrrell reports two distinct sets of glacial striae: an earlier one tending south, 65° west, parallel to other striae seen almost everywhere along the shore and doubtless made by the ice sheet from the northeast; and a later one, tending south, 35° west, probably made by a local glacier descending from the high land to the north after the greater ice sheet had withdrawn.

> A portion of the moraine of this later local glacier may be seen as a great stretch of huge broken masses of rock, forming a prominent point, and covering the shore for a considerable distance beyond it. . . . . Athabasca Lake is here five miles wide, and lies in a long narrow valley with a steep sandstone escarpment between 400 and 500 feet high on its south side. The later glacier from the north flowed into the valley at this point, and probably reached across to the south side, completely filling it and damming up the water from the east to the height of the sandstone plain on the south, which is at about the level of the high benches previously described on the banks of Cree River and along the west shore of Black Lake. The occurrence of an ice dam across the valley accounts fully for the former existence of a large lake in the present basin of Black Lake. Without the ice dam, or some other dam of which no evidence can be found, the water of Black Lake could not have stood much above its present level in glacial or post-glacial times, for the great valley of Athabasca Lake, which extends eastward to Black Lake, dates back to a period long before the glacial epoch.

The formation of this dam is important in the consideration of the drainage of the great lakes formed in the Athabaska and Peace river valleys to the west. Tyrrell does not seem to appreciate the fact that for a long period the northward drainage of the Athabaska Lake Valley was blocked, and that consequently the waters of Hyper-Athabaska Lake must have stood high and the natural outlet of these waters would, at one time at least, be by way of Black Lake and the Stone River Valley; and, therefore, the damming would probably have more to do with the closing of a possible outlet of Hyper-Athabaska Lake than the formation of a Hyper-Black Lake. As has been already suggested, the writer believes this damming separated the confluent waters of Hyper-Athabaska and Hyper-Black lakes, allowing the rapid drainage of the smaller Hyper-Black Lake eastward, while the water still remained high in Hyper-Athabaska Lake.

PEACE RIVER VALLEY

If one stands on the plain level above the town of Peace River, an extended view both up and down the valley of the Peace is available. The strikingly flat character of the plain level is apparent, and, if one could extend his vision, he would be struck by the similarity of elevation between the level on which he stands and that of the high lands lying to the north and the east. The elevation of the plain at Peace River is 2,250 feet above sea-level. That of the Watt Mountains is about 2,700 feet, and that of the Eagle Mountains is about the same. Caribou Mountain Plateau is slightly higher. The summit on the twenty-ninth base line is 3,225 feet, and to the northward the elevations probably average over 3,500 feet. Buffalo Head Hills and the Birch Hills average about 2,700 feet, and the plain level at the end of steel on the Alberta and Great Waterways, sixteen miles from McMurray, is 2,500 feet. This similarity of elevation is conspicuous, and can only point to the fact that these present outlying plateaux were in recent geological times connected and formed a continuous plain of fairly uniform relief.

At Peace River, the valley of the Peace is both broad and deep, and yet it is evidently well filled by the river it contains. Here

is no river flowing sluggishly in a valley much too large for itself, but a mighty stream which, still in its youth, has carved and is still carving a valley in just proportion to its size.

On descending the river below the town, the valley walls contract to gorgelike proportions, and the apparent crest of the valley gradually lowers. Ascending to the crest at a point some 50 miles below Peace River, one would find himself on another plain level at a lower elevation than that above Peace River town.

The plain is narrowed to a width of about 50 miles, but is distinctly flat. It is bordered on the east by the shoulder of Buffalo Head Hills, and on the west by a southerly extension of the Watt Mountain Plateau. The elevation of this plain is about 1,600 feet.

Descending the river still farther to a point near Battle River and there scaling the immediate valley walls, another plain level confronts the eye on reaching the top, this time at an elevation of 1,100 feet. East or west from the river this plain stretches some thirty to forty miles before rising gradually to a comparatively narrow bench land at an elevation of about 1,600 feet which must be crossed before ascent can be made to the old, original plain level.

About 50 miles above Vermilion the Peace River swings rapidly eastward and, the valley walls receding, it enters a widely extended plain area at an elevation of about 800 feet which, at Vermilion, stands scarcely more than 30 feet above water level. This plain level is practically continuous with the basin of Athabaska Lake and extends northward around the foot of Caribou Mountain Plateau to the basin of the Great Slave Lake.

WABISKAW AND ATHABASKA RIVERS

Strikingly similar features to those outlined above are to be found in the valleys of the Wabiskaw and Athabaska rivers to the east. These are well brought out in the profiles of the base, lines and meridians of the Dominion Topographical Surveys as shown in the accompanying sketches (Fig. 2).

The 1,600-foot level shows as the broad plain south of Hay River on the sixth meridian; distinctly on the shoulder of Caribou Mountains on the twenty-ninth base line; on both slopes of Birch Hills on the twenty-seventh base line; on both sides of the

valleys of the Peace and Wabiskaw rivers on the twenty-sixth; on the Peace, Athabaska, and Wabiskaw valleys on the twenty-fifth; slightly on the Peace and Athabaska rivers on the twenty-fourth base line and just faintly on the east side of the Athabaska River on the twenty-second base line.

The 1,100-foot level shows on the northern half of the broad plain of Hay River on the sixth meridian; throughout the greater

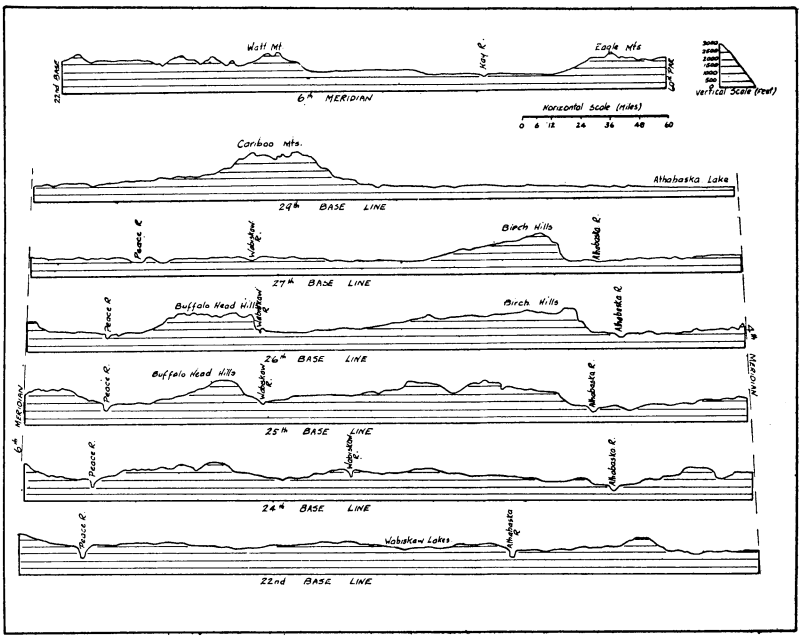

FIG. 2.—Profiles of base lines and meridians of the Dominion Topographical Surveys, Department of Interior.

part of the twenty-seventh base line; somewhat on the Peace River and very pronouncedly on the Athabaska River on the twenty-sixth base line; and on the Athabaska River only on the twenty-fifth base line.

The 800-foot level shows between the fourth and fifth meridians on the twenty-ninth base line; and in two places on the twenty-seventh base line—the valley of Athabaska River, and near the fifth meridian.

HAY AND BUFFALO RIVERS

A trail leads overland from Vermilion, on Peace River, to Hay River. For about 80 miles northwest from Vermilion it traverses a flat plain at an elevation of about 800 feet above sea-level. It then crosses a low divide, the summit being at 1,500 feet, and enters the long, narrow plain area in the center of which flows Hay River. The elevation of this plain at its upper end is about 1,100 feet. Hay River follows this plain in a northeasterly direction for 150 miles, dropping scarcely more than two feet to the mile, until, within 50 miles of its mouth, it falls abruptly over an escarpment into the basin of Great Slave Lake, forming Alexandra Falls (Figs. 3 and 4).

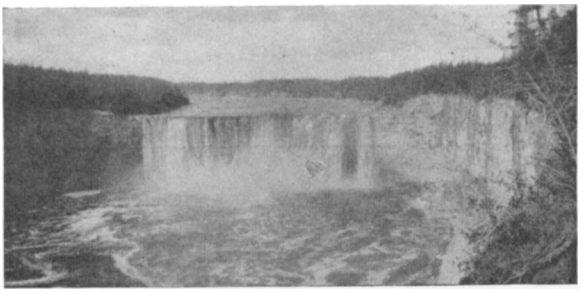

FIG. 3.—View of Alexandra Falls, Hay River, N.W.T., looking upstream. (Photo by A. E. Cameron, 1916.)

SLAVE RIVER

At Fort Smith the Slave River cuts through a poorly developed escarpment some 125 feet high. The crest of the escarpment shows distinct evidence of the shore-line conditions in the form of well-developed sand dunes and a flat horizon to the north and east. West of Fort Smith at

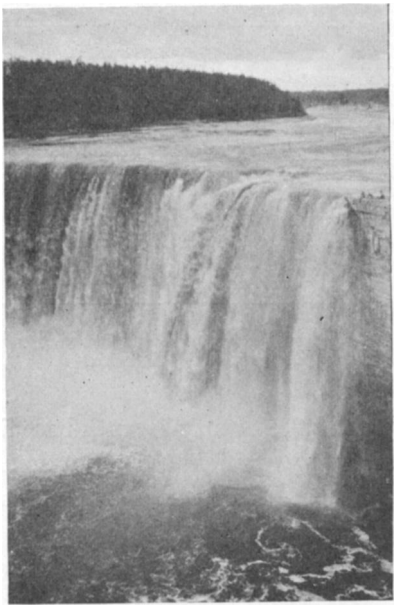

FIG. 4.—View of Alexandra Falls, Hay River, N.W.T., showing close view of escarpment. (Photo by A. E. Cameron, 1916.)

Salt River an abandoned lake basin is distinctly shown in the salt plains lying at the foot of an escarpment facing east (Figs. 5 and 6). The plains are for the most part void of vegetation and form a broad flat, water-soaked in the wet season and salt-incrusted in the dry. Shore-line conditions are shown by narrow spruce- and

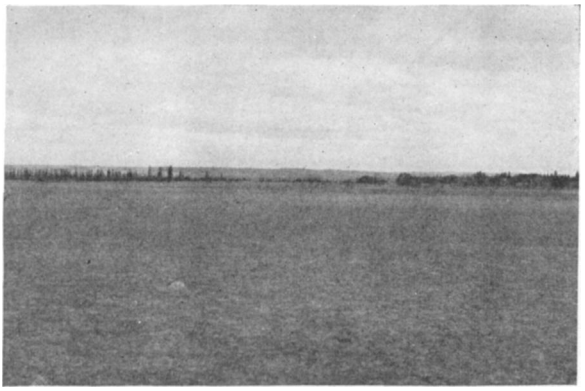

FIG. 5.—View of the salt plains on Salt River, west of Fort Smith, N.W.T. (Photo by A. E. Cameron, 1920.)

FIG. 6.—Another view of the salt plains on Salt River, west of Fort Smith, N.W.T. (Photo by R. T. Hollies, 1920.)

poplar-clad points jutting out from the irregular face of the escarpment into the clay flats, bordered frequently by bowlder pavements or shingle beaches. Low off-shore islands showing water-deposited material are also noticeable (Fig. 7). The Salt River escarpment

follows north down the west side of Little Buffalo River for about 30 miles and then gradually disappears to the west.

GREAT SLAVE LAKE

Great Slave Lake lies at an elevation of about 500 feet above sea level. The south shore of the lake near Pine Point, west of

FIG. 7.—Small island in salt plains, west of Fort Smith. Salt spring deposits in foreground. (Photo by A. E. Cameron, 1920.)

FIG. 8.—Wave-cut limestone bluff at elevation of 200 feet above Great Slave Lake. (Photo by R. T. Hollies, 1920.)

Resolution, rises rather steeply for a few miles, showing storm-built beaches of limestone shingle, to a limestone bluff at an elevation of about 700 feet (Fig. 8). Inland lies a rolling country which rises gradually to the south. Each roll shows limestone shingle beaches and bowlder pavements, and not a few are topped by sand dunes.

Each roll may be traced eastward to where it pinches out into the hollows between. The trend of these rolls conforms closely with the direction of ice movement as established by glacial striae at various points along the lake shore. Each roll can only represent a point, carved out by the glacier when it was excavating the basin, around which the waters of the lake lapped at some stage in its development.

FIG. 9.—View of shingle beach, at elevations up to 150 feet above present lake level, Great Slave Lake, N.W.T. (Photo by A. E. Cameron, 1916.)

FIG. 10.—View of shingle beach, at elevations up to 150 feet above present lake level, Great Slave Lake, N.W.T. (Photo by R. T. Hollies, 1920.)

Elsewhere about the lake shores undoubted lake beaches and wavecut cliffs are observable at various elevations above the present lake level. They are very numerous and excellently well developed, and are noticeable wherever high land exists in the vicinity of the present shore line (Figs. 9 and 10).

TERMINAL MORAINES

In the valleys of Hay and Buffalo rivers occur terminal moraines, marking positions of the ice front during stages of halt or of slight

re-advance of the ice sheet during the general retreat from the region. The moraines consist of low ranges of irregularly shaped hills, somewhat higher in elevation than the adjacent country, and trend in a general direction at right angles to the movement of the glacier, as shown by glacial striae. The best-developed moraine occurs immediately north of Buffalo Lake. The morainic hills here have an elevation of 200 to 300 feet above the surrounding country, and form a dam behind which the waters draining from the north slopes of Caribou Mountains are ponded, forming the large shallow body of water known as Buffalo Lake. This moraine extends north to within a few miles of Great Slave Lake. Two moraines were noted in the valley of Hay River; one tending to connect the Watt Mountain Plateau with that of Eagle Mountains; and the other, the Caribou Mountains with Eagle Mountains. The low ridge of glacial drift now existing between Watt and Caribou mountains and forming the present watershed between Peace and Hay rivers appears to be an interlobate moraine formed between two lobes of the waning glacier.

PROBABLE LAKE EXPANSIONS

From this somewhat scanty evidence an attempt may be made to outline the various stages of lake formations developed as the continental ice sheet retreated from the region.

At least three definite glacial lobes are apparent in the area. One extended up the valley of Hay River; a second swung west, south of the Caribou Mountains, and probably sent tongues up the valleys of the Peace and Wabiskaw rivers; while the third lay in the basin of Athabaska Lake with its tongue pointing up the valley of Athabaska River.

The first stage to be considered (Fig. 11), is when the water level stood at about 1,600 feet. The Hay River lobe extended up the valley to a point south of the sixtieth parallel. The edge of the other lobes is not determinable from the information at hand, but it would appear that the Peace River lobe extended well up toward Vermilion and probably sent a tongue south up the valley of the Wabiskaw to a point close to the twenty-sixth base line; while the Athabaska lobe must have extended at least as far south as this same line. The similarity of elevation of the lake benches

in all the valleys can only point to the fact that the waters were in conjunction with one another. Those in the Hay and Peace river valleys undoubtedly were connected through straits between Caribou Mountains and Watt Mountains. The other connections were apparently by marginal channels along the ice front. Drainage northward by way of the Mackenzie River was blocked, and it

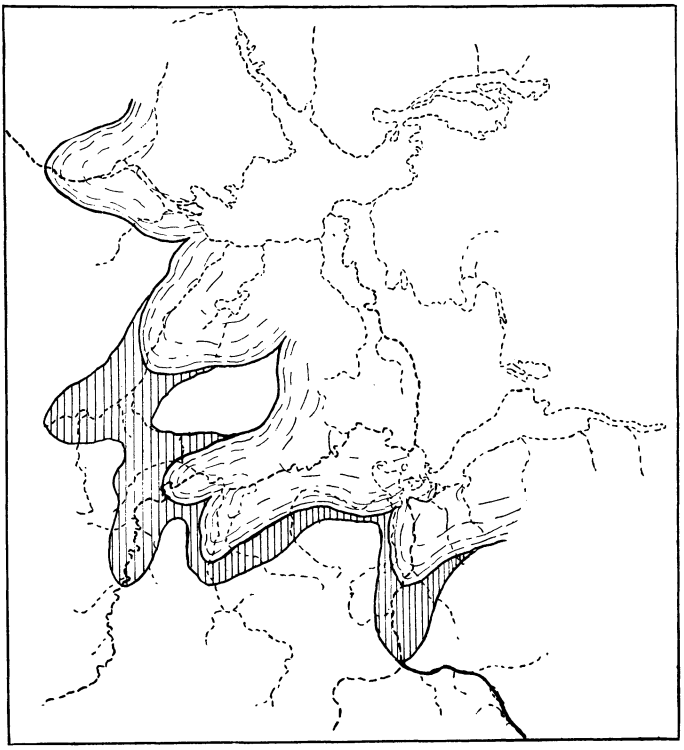

FIG. 11.—Outline map showing probable position of Keewatin ice sheet and lake expansions when the water stood at the 1,600 foot level.

seems likely that the lake in the Athabaska Valley was somewhat lower in level than the others, and may have been drained eastward toward Hudson's Bay. The more probable outlet, however, was by way of the Clearwater River and Methy portage to the Churchill River Valley. The summit of Methy portage is 1,735 feet above sea-level—scarcely more than 200 feet higher than the lake level at that stage. This difference could easily be accounted for by

differential elevation of the land following the retreat of the ice front.

In the second stage (Fig. 12) the water level stood at about 1,100 feet. The Hay River ice had retreated to the morainal ridge north of Buffalo Lake and the Peace and Athabaska lobes had similarly retreated. Drainage down the Mackenzie was

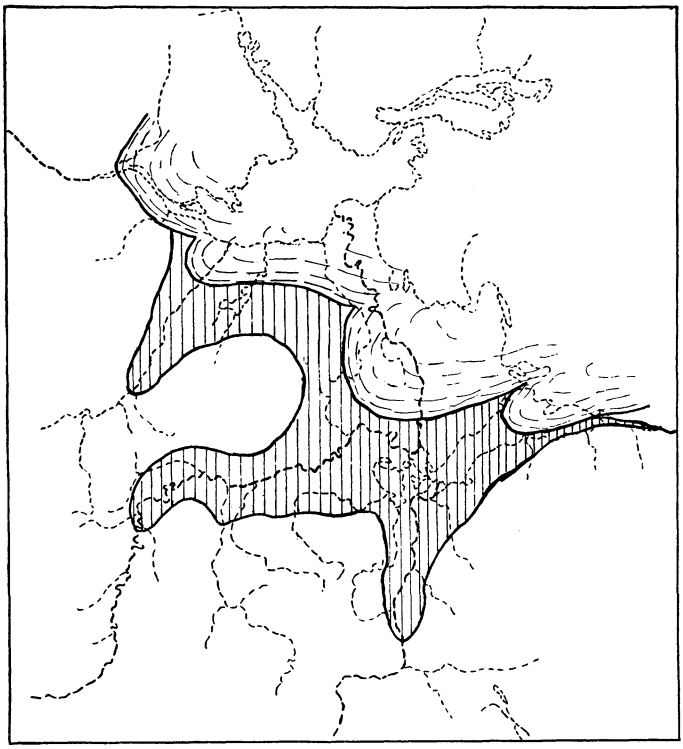

FIG. 12.—Outline map showing probable position of Keewatin ice sheet and lake expansions when the water stood at about the 1,100 foot level.

still blocked, the lake basins were all continuous, and outlet must have been by way of Fond du Lac on Athabaska Lake, in the long, extended arm of that lake, and thus eastward, probably by way of Churchill River.

The Mackenzie River outlet must have been cleared soon after, but was apparently blocked farther north, for we find the water level standing at 800 feet and developing beaches on all sides of

the present shore line. At the 800-foot elevation (Fig. 13) the ice had receded clear of Athabaska Lake and practically clear of Great Slave Lake, though a small tongue remnant of the Great Slave Lake lobe may have occupied the eastern extension of the lake. The water level was well below the Fond du Lac outlet on Athabaska Lake, but the Mackenzie Valley was open and drainage

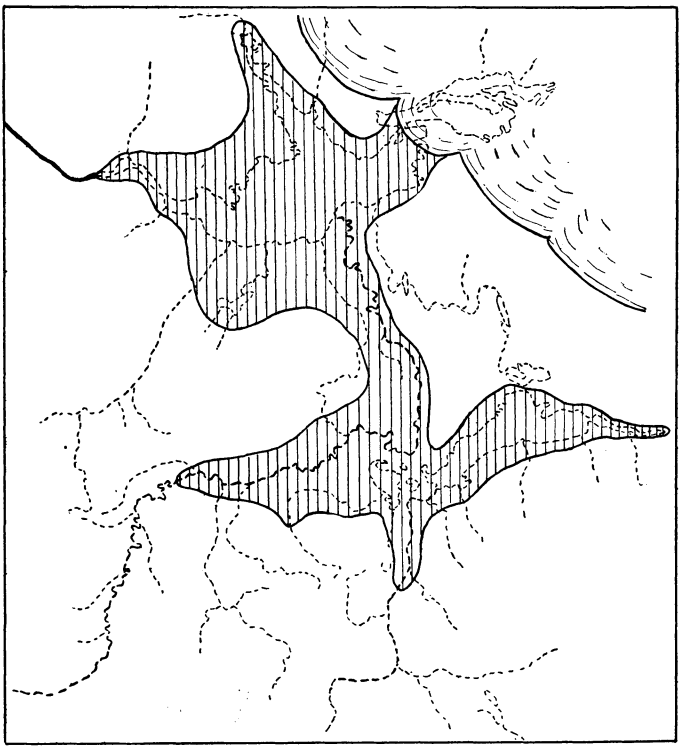

FIG. 13.—Outline map showing probable position of Keewatin ice sheet and lake expansions when the water stood at about the 800 foot level.

should have been that way. The two main basins are continuous by means of a narrow strait across the low escarpment at Smith. The Great Slave Lake basin was expanded to take in the present basin of Buffalo Lake, though probably low morainal islands marked the position of the morainal ridge north of Buffalo Lake.

On the retreat of the ice, isostatic readjustment of the land areas took place, with a raising of the land in a series of differential

elevations to the north and east, possibly on successive hinge lines. The area south of McMurray was probably differentially raised, causing elevation of the Methy portage outlet, and, later, movements developed in the neighborhood of Fort Smith, raising a land barrier there about 125 feet high, and causing a separation of the two basins (Fig. 14). We thus find two large bodies of

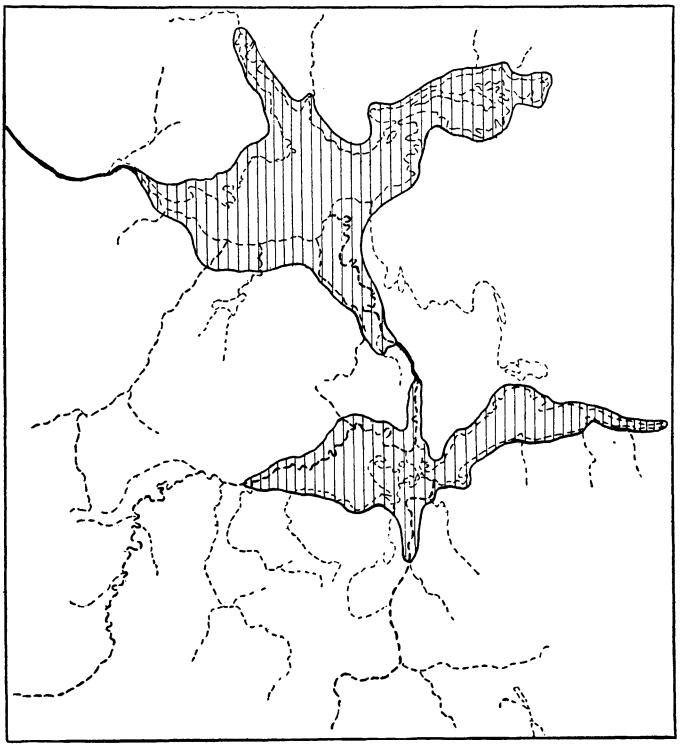

FIG. 14.—Outline map showing probable lake expansion when water stood at the 700 foot level.

water existing in the separated basins: Athabaska Lake, standing at about 750 feet, and Great Slave Lake at some 600 feet.

The two basins have acted very differently since their separation. Isostatic readjustment north of Athabaska Lake has tended to close the outlet, keeping the waters ponded back, and drainage has been accomplished by Slave River cutting its channel as fast as the ground rose. As a consequence the water level has dropped

only slightly since that time. The level of Athabaska Lake is now 699 feet above sea-level at average water conditions.

Northward, however, conditions are very different. The outlet of the basin lies at its western corner, and differential elevation to the north and east has only had the effect of spilling more water down the Mackenzie River, with the result that the basin has been rapidly drained. The rapidity with which the water level fell on Great Slave Lake is excellently well shown in the storm or seasonal beaches found on the forelands, particularly along the north shore. At one place on Windy point over 100 such beaches are observable in an elevation of some 250 feet, and the crest of the hill is marked by a horseshoe beach developed as the ground rose above the water level. The beaches are of fairly uniform depth, and throughout most of the rise occur as a series of very regular waves, indicating that elevation has been at a constant, uniform rate. That movement is still going on is apparent from the beach lines built up in recent times.

In conclusion, the writer can only admit that these are wide generalities based on very insufficient data, and undoubtedly will bear much correction. He feels sure, however, that the outlines suggested are at least approximately correct. Much work has yet to be done, and detail work on the problem would yield many points of scientific interest. One main problem that presents itself is the study of the Great Slave Lake shore lines with a view to determining the time period since the last glacial age. Dr. A. P. Coleman produced[1] much interesting information on this subject by a detail study of raised beaches, delta deposits, and lake bars on Lake Ontario. The seasonal beaches of Great Slave Lake, studied in detail, would give similar information. The Alexandra Falls on Hay River have receded 6.5 miles since their original development—a distance almost equal to that of Niagara Falls. Slave River has completely filled up the long, southward-extending arm of Great Slave Lake, and is still building rapidly into the present lake. The rate at which alluviation is taking place could be readily determined, and an excellent time record seems available.

December, 1921

[1] A. P. Coleman, *Proceedings of the International Geological Congress, Toronto, Canada, 1913.*